

When his big processors couldn't wear the IBM logo, he came up with a new label as well
—and fathered an industry in the process.

THE EARLY CHAPTERS OF THE PCM STORY

by Gene M. Amdahl

GENESIS In early 1969 while I was director of IBM's Advanced Computing Systems Laboratory at Menlo Park, California, we were going through a cost/pricing cycle to determine whether or not our proposed very large computer could be successfully offered to the marketplace. Our financial analysis was indicating quite clearly that there was no hope for anything but a loss if the single large processor was the only offering. If the next smaller size processor was included, we might break even; and if a third product could be included, normal profit could be attained for all three.

This analysis was being performed on a product plan which involved the introduction of medium scale integration of very high speed circuitry into a highly overlapped sequential processor for the top end of the 370 family. Such an analysis was always performed to determine the viability of a program in IBM's product plan. Further elements of interest were that the design of the processor had only been blocked out, the design of the medium scale integration circuitry was in its early stages, and design automation problems were as yet insurmountable. But the characteristics of the high speed devices and the machine organization were well enough known to justify the performance and cost analyses we were undertaking.

It was recommended to top IBM management that three processors be placed in this technology in order to achieve normal profit; building only one or two processors was not recommended because they would incur a loss or produce only marginal profit. Top management's decision was to consider only the

original charge, that of building only one large processor using the technology. My response in turn was to recommend that the Advanced Computing Systems Laboratory project be terminated, for there was no hope that any product contribution could result from its activities. The Laboratory was duly closed in late spring of 1969. Although I didn't recognize it at the time, my prospects of building those large processors I envisioned under the IBM label were closed off with the lab.

The price range considered for the large system, relative to its performance, had to conform to the price/performance relationships of the rest of the 370 line. This was so because the machines were all compatible with one another; thus, the pricing on any one member would affect the pricing of another. If the large system could have been priced independently of an established price/performance curve it could certainly have been profitable, although it probably would not have generated what IBM would consider a "normal" profit.

After closing the lab's project I spent some weeks analyzing what I had learned, and identified several policies I felt should be changed for IBM to profitably put its best technical foot forward at the high end of the computer line. I requested an audience with the then top three executives of IBM, Mr. T. Vincent Learson, Mr. Frank Cary, and Mr. John Opel, which was granted one day in the summer of 1969. They gave an attentive hearing to my presentation of the effects of the existing versions of those several policies and the expected consequence of the changes. The net response to my presentation was general concurrence with my analysis, but a final statement that to change any one of those policies would not be in the best interests of the company.

During the next year I did a great deal of thinking and finally concluded that IBM's financial returns quite clearly

would always be optimized by compromising the high-end offering. This represented a dilemma to me because this was the area of my greatest interest and I had a great deal of pride in the quality of the technical undertakings with which I was involved. Basically, I had to make a decision either to live with such frustration, to attempt to change my area of interest to smaller machines, or to recognize that IBM's desire to optimize its financial return represented an Achilles' heel which I could exploit if I were to leave and go into the large computer business in competition with IBM.

EXODUS It is quite likely that I would never have quite found the occasion to actually resign if there had not been a concurrent development in the summer of 1970. Some five years earlier my brother had started a consulting company by the name of Compata, and IBM had granted me permission to become a director of that company so long as there was no conflict of interest. Some time in the early summer of 1970, IBM management was told that Compata had developed a minicomputer which it was offering on the market and therefore that I was in violation of the IBM conflict of interest requirement.

In late summer the company sent me a letter indicating that its investigation of the charge showed no basis for a conflict of interest (apparently the informant had thought the front-end communication mini offered by COMPAT in the spring of 1970 was an offering from Compata) and that IBM would allow me to retain my shareholdings in Compata. They felt, though, that it looked questionable to have an IBM employee on the board of directors of another company in the data processing field regardless of its noncompetitive nature. Since this was a recession period, Compata was in difficult financial circumstances, and I felt it most inappro-

pritate to leave its board at such a time. This was the deciding point for my resolve to resign and to undertake the Amdahl Corp. venture. I did so in late September 1970.

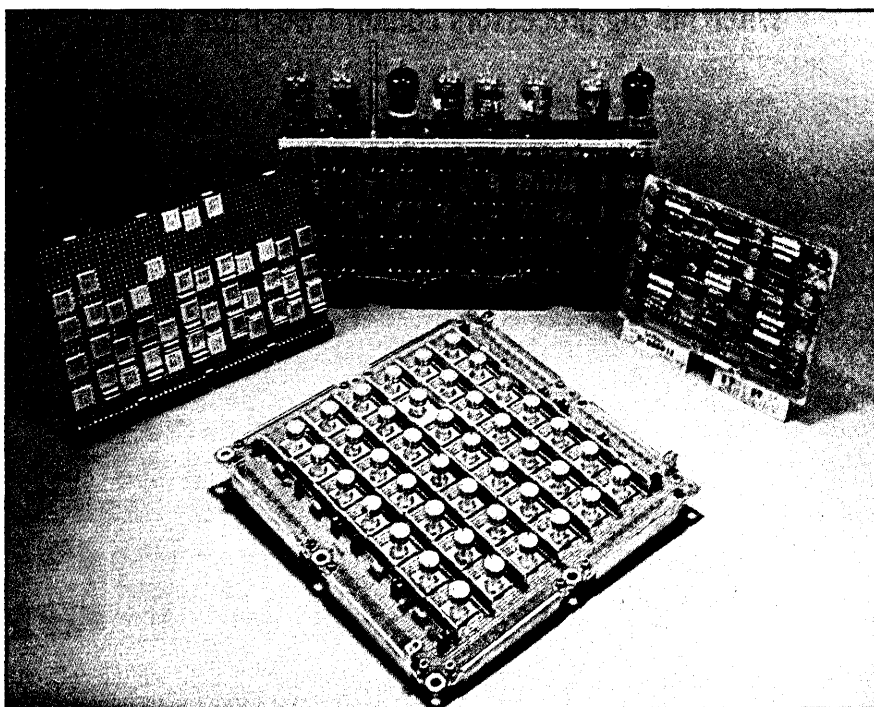
It was clear that IBM did not share my view of the high end of the market. After turning in my letter of resignation, which made no attempt to disguise the business I was going into, Msrs. Learson, Cary, and Opel asked me again to meet with them. That meeting resulted in no change of plans on either side. Reading this in our expressions as we left the room, "Spike" Beitzel, then my group's vice president, hurried after me in the hall. Putting his arm around me, he said earnestly, "Just as a matter of personal concern, Gene, don't go into the large systems business. There's no money to be made in it."

He was not the only person to feel that way, and to say so. Although some of the people on the technical side were convinced the technology could be developed, the financial officers were equally convinced that it couldn't be pulled off profitably. They were almost right.

It has often been remarked that I brought a technical team with me when I left IBM. Such statements are slightly exaggerated, for only a young financial man (Ray Williams) and two secretaries (Marjorie Slaughter and Susie Warren) constituted the IBM contribution. The only other technical person at the beginning was an engineering executive (Ralph Rodriguez) who came from EM&M. The remaining early technical staff came, starting some three months later, from three other young computer companies which failed to attract further financing and went bankrupt during Amdahl Corp.'s start-up period.

LEVITICUS The selection of large computers wasn't simply satisfying a personal whim, but rather an optimization under the influence of a number of "laws" governing the marketplace. The large computer market segment possesses several characteristics which present significantly greater opportunity in the data processing field than does any other segment. The characteristics which enhance opportunity in the start-up period for a new computer company are customer self-assurance, greater customer propensity for long-term commitment, easier customer identification, and large revenue contribution per system for maintenance. After the start-up period, this end of the business still offers the characteristics of market concentration and relatively high growth rate.

To have customer acceptance for a large commercial system, the offering must be compatible with the customer's existing application development investment. These customer investments in application development span well more than a decade within a single architectural



Dr. Amdahl has designed computers in all generations: first, vacuum tubes (IBM 704, background); second, transistors as discrete components (as in IBM 7030, board at right); third, integrated circuits (as in IBM 360, 370, and 303X, left); and current large scale integration (as in Amdahl 470, multichip carrier in foreground).

al approach like that of the 360/370. Their investments in these committed applications total several times their investments in the computers themselves. Even more important, the successful operation of their enterprises have become dependent upon continuous processing of these applications.

The concept of compatibility with these existing investments is a prerequisite to broad acceptance of a new computer within the large system market segment. These customer investments also introduce a very large element of conservatism in this market segment, forcing a manufacturer to make evolutionary rather than revolutionary successors in his product line and largely limiting competitive battle zones to the control of modest architectural change and technological innovation.

To construct a successful competitive strategy at the high end requires attending to the product cost and performance, the product availability and serviceability and, for good measure, the image of technological leadership. In the IBM 370 product line the various entries were spaced with uniform price/performance relationships to integrate them into a powerful force for revenue and profit control. The technology employed was also related through the line, providing sound economic bases for most members of the range, but prematurely limiting both the top and bottom. The economics in this environment practically precludes "wild duck" offerings at the upper or lower ends, for all the products must fly in for-

mation.

That is the case unless you are *competing* against such a line. To make a competing system possessing the desired characteristics would certainly be much easier to accomplish using a more advanced technology than that utilized by the competitor. If a more advanced technology could be developed, a system superior to the originator's largest integrated offering would be most appropriate as an entry, for the marketing reasons already given.

The only weakness to the large system approach is that it is a very high cost development, a high risk development, and a long term development—all of which has to be financed on faith before any "show and tell" revenue can be derived. This in itself calls for a carefully worked out strategy for bringing in capital and revaluing the stock according to a regular schedule in order to preserve the value of early investments and still attract new capital. Such a scheduling strategy requires a certain amount of cooperation from the investment environs, although it can be made somewhat insensitive to moderate investment fluctuations.

NUMBERS The generation of the business plan for Amdahl Corp. showed we would need from \$33 million to \$44 million before we would achieve a positive cash flow, depending upon how quickly we wanted to get into the market. Clearly, raising this amount of money in one step was most improbable, particular-

ly in the economic circumstances of 1970. The exuberant stock market had begun to wane in 1968 with the introduction of the higher capital gains tax and the recession. Having had no experience in the venture capital field, I was really unaware of how grim the situation regarding venture capital had become. Studying the business plan, two appropriate milestones were identified which would permit a three-phase financing starting with \$5 million, adding \$12 million in the second phase, and the remainder in the third phase. The amounts of money were determined as being adequate to carry us for six months beyond the milestone in each case, to give adequate time for "show and tell" in the succeeding financing rounds.

In approaching the venture capital community it quickly became apparent that very little interest was shown even in proposing a more modest sum. Investors indicated that they did not think there was room for another computer company, in particular not for one that would be in head-on competition with IBM—their contention being that any time IBM had the whim it could pull the rug out from under our feet. In addition investors didn't think it was possible to make a computer compatible with the IBM line; after all, wasn't RCA unsuccessful? It wasn't until we talked with Heizer Corp. that we got any positive interest, and they were interested enough to offer an initial investment of \$1 million. We considered that offer in the light of whether or not there was any milestone that we could reach on that amount of capital, and concluded that there was nothing of adequate substance to attract follow-on investors. However, we did ascertain that at \$2 million it was possible to identify the first meaningful milestone, that of proving the circuit technology, and have some three months operating time to spare for a second round of what would now be a four-phase financing. The milestone for the \$2 million investment was to be the successful demonstration of a precursor model, which would embody samples of the new technology to be developed, interconnected in a representative long logic path through the proposed computer system.

We went back to Heizer Corp. and indicated our unwillingness to try the venture with a \$1 million financing, but that we thought a logical financing sequence could start at the \$2 million level. The Heizer people agreed, and some three months after leaving IBM, Heizer made its investment of \$2 million in Amdahl Corp. The closing of this investment took place the day after our receipt of an overdraft notice from the Bank of America, which informed us that the founders' investment had been totally expended. We had known we were reaching the end of our rope, and had done the last of our negotiating with the realization that if Heizer didn't come through, it was all over for Amdahl Corp. We tried not to let that show.

We weren't alone in this predicament.

While these negotiations with Heizer were going on, there were three other young computer companies seeking funding: MASCOR, on the San Francisco peninsula; Berkeley Computers in Berkeley; and Gemini Computers of Orange County. Heizer had considered all three of those investments concurrently with ours and chose ours as the most viable undertaking. In due course, within the latter part of 1970 and early part of 1971, all three of those other companies went bankrupt due to lack of additional financing, and technical people from those three organizations formed the elite team of technology and computer developers at Amdahl.

The financing situation had been so grim that it became apparent that the three months after our first technical milestone would have to be used only for the final negotiations and that the investors for the second round would have to be largely sold on the concept of Amdahl Corp. before the next milestone was achieved. So, throughout the eight months from first investment to first major milestone we diligently scoured all of the venture capital community from coast to coast once again, raising no positive interest.

Fortunately, in that same period we had been contacted by Fujitsu Ltd., within which we had some long standing personal ties. Fujitsu demonstrated an interest in our undertaking and asked if we would consider a joint development program with them and a licensing under our patents. We indicated a willingness, provided this venture would be accompanied by an investment, and Fujitsu agreed to provide \$5 million, all of the funds required for the second round of our four phases of financing, enough to complete the logical design of the machine. The timetable for the investment was right on and the investment was concluded one month after the first major milestone was achieved.

Again, using this new milestone and the second round of financing we immediately set out to prepare the venture capital community for our third round. This time there was a little more substance to the achievements of the company and to the magnitude and quality of the investment behind it. For almost one year we labored at attempting to put together the third round, but could make nothing gel.

Finally in September of 1972, one of Nixdorf Computer AG's finders dropped in on us unexpectedly and became extremely interested, almost excited. This was followed up within two weeks by a visit from several of Nixdorf's top technical people and by the arrival of Heinz Nixdorf himself at the end of that stay. Nixdorf was so positive that he agreed to make an investment of \$6 million if we would be willing to negotiate a business arrangement with him in Europe within a set of agreed-upon boundary con-

ditions. Nixdorf's principal interest was to establish a relationship between Amdahl Corp. and Telefunken Computers, in which he had half interest.

We required Nixdorf to make his investment as a first step in this negotiation, and he agreed to do this. This commitment made the U.S. venture capital situation gel within the following week. The excitement shown by Nixdorf made Fujitsu somewhat concerned about the closeness of its relationship with us, so Fujitsu requested that we agree to its matching Nixdorf's investment. Of course we were happy to comply. The total funding in this third round was \$20 million, enough to build a prototype and ready our manufacturing facility.

Our negotiations with Nixdorf for the business activities did not go as well as hoped by either party. To us it appeared that the Telefunken people who were not involved in the original Nixdorf decision felt very threatened by the appearance of Amdahl on the scene and proceeded to question the market size projections, the possible market penetration, and to some extent even the viability of the technology and the computer design. This made the Nixdorf people, who were unfamiliar with the very high end, feel rather nervous and unwilling to negotiate any longer within the boundaries we had agreed upon. We in turn were unwilling to negotiate outside of those boundaries, so we remained at loggerheads and the situation became totally irreconcilable.

Early in 1973 we decided to try to make the fourth and final leg of the financing a public offering. The 470/6 (a pre-virtual memory model) was expected to be ready for first customer shipment in about one year. We talked to a number of underwriters but were not successful in stirring up much interest in floating a public offering in that stock market environment. We did, however, finally find one underwriter that was interested in developing an underwriting capability in the high technology area, and because of this interest was willing to risk a poor market reception. We proceeded to develop the offering document and had it ready for submission to the SEC when suddenly the underwriter had to cancel the plans; its securities holdings had just dropped sufficiently in value so that they no longer met the capitalization requirements to handle the underwriting.

This occurred in June, and for the next three months we traveled all over Europe, Canada, the U.S., and Japan hunting for any additional private funds, with no ray of hope generated. However, during that three-month period a successful new venture offering was made by Hambrecht & Quist for Modular Computer Corp. When we once more decided to try an underwriter, it showed interest, and we hurriedly reworked our offering document, readying it for submission to the SEC at the end of October 1973.

During November we met with

many investment groups presenting the characteristics of Amdahl Corp., and in early December headed to Europe to hold similar discussions in London and in Geneva. At London the first of our meetings was scheduled as a luncheon. The attendees arrived almost an hour late and with very unhappy expressions. That morning on the London stock exchange had had the largest drop in its market since 1929. We dutifully completed our presentations in Europe but with significantly lower optimism.

On our return to the states, the SEC inspector had not yet completed his list of queries regarding our submission. As fate would have it, one week later we had to start over again at the SEC, for the inspector handling our submission left the SEC to join the newly formed President's Energy Council. All during this period the stock market in the U.S. was falling rapidly, and with this new complication we gave up hope of a public offering and decided there was no alternative but the private market, even though we had no positive expectation from that source either.

This time we turned our attention to our existing investors because the only hope at this point was that they would be willing to make further investments to preserve the funds already at risk. This was a long hard-fought bitter struggle which went on all through 1974 but which resulted in the commitment of some \$18 million more, making the completion of the undertaking possible.

Also at the time we gave up hope on the public market, we decided we had to drop the then almost completed real memory version of the 470. This decision was made on the basis that, with the introduction of virtual memory by IBM, the market penetration and long-term commitment characteristics were not adequate to develop an early positive cash flow; consequently, the machine would be a drain on our resources while we would be completing the undertaking of development of the virtual memory processor to follow. This decision left the company with approximately 1½ years additional delay before first customer shipment and a need for almost \$25 million more to bridge that time gap. Fortunately, that amount was made available to us by Fujitsu in the form of inventory loans and operating loans.

One of the many ironies in getting our computer company going was that its major backers were also computer companies—in fact, the only two non-U.S. computer companies of any stature which were operating in the black at the time.

DEUTERONOMY 1974 was made up almost exclusively of product development activities. The virtual memory version (the 470V/6) was constructed and debugged. First customer testing of the machine was carried out by a group of German computer experts to

satisfy the German Ministry of Science and Technology that the proposed Amdahl product was essentially as advertised. One year later these tests culminated in the installation of our first two machines in Germany, one at DFVLR (the German equivalent of NASA) and one at the Max-Planck Institute, both near Munich.

Even though the product could be successfully tested in November we elected to keep the machine in house for exhaustive testing to find latent design problems or potentially unreliable componentry. In retrospect, this care in making certain that the first machines to be installed in the market would perform reliably may well be one of the most important decisions that governed the future acceptance of Amdahl products.

Our intense marketing effort began in early 1975. This was the period in which we would be testing our perception of the "laws" governing the marketplace. In particular, the two primary laws we would be testing were customer self-assurance and the greater propensity for long-term commitment. This was so because we decided it would be essential, in light of our historical capital funding experience, to develop a positive cash flow. The only way in which the positive cash flow could be achieved was to require that all of the early systems be purchased. This surely required our early customers to have a great deal of faith in their ability to analyze all of the technical and business aspects surrounding their clearly full-term commitment to our product. Fortunately for us there were such intrepid pioneers extant in our marketplace.

For our first installation in June of 1975, due to some governmental financial regulations which had been inadequately prepared for, our first revenues did not appear until the first week of October, although this first machine was accepted by the customer within the 30-day acceptance test period offered for the early machines. In fact, the computer was installed, brought up, running, and made available for customer test within a week-end. Fortunately, the acceptance, not the payment, influenced our successive customers.

Each of those early customers was hard to identify in advance; probably the majority of them had themselves initiated the contact with Amdahl. In turn, each of these early customers was remarkably effective in developing interest in our equipment on the part of the potential next customer. This word of mouth advertising was our most potent marketing tool for the first couple of years.

We found in this period that most of our expectations as to factors influencing customer acceptance were born out rather precisely in the marketplace. There was, however, one deviation that we had not expected—what we discovered was that quite a high percentage of our customers ended up having our computer as

their sole large computer, whereas we had expected that such an occasion would be rare or nonexistent.

The purchase-only policy had a very significant positive effect—our first quarter of revenues (fourth quarter of 1975) was profitable for the company, and each quarter thereafter has seen a profit and a positive cash flow. By the time Amdahl finally went public in August 1976, it was not from a need to obtain operating monies but rather was largely aimed at requiring the conversion into equity of the outstanding convertible debt instruments in the hands of our early investors—which had made our balance sheet an awesome credibility hurdle for our customers to leap in perceiving Amdahl Corp. as a viable supplier. The public offering achieved this purpose very effectively. It provided a higher level of recognition of our company on the financial side of the customer prospects' organizations.

The success that Amdahl Corp. achieved in its early market experience established not only that it was possible to build compatible computers, but also that it was possible to obtain customer acceptance, to provide the hardware and software support adequate to synergize this acceptance, and to grow rapidly while doing it. Perhaps the most sincere recognition of this success was the sudden appearance of other companies emulating our activities. *

DR. GENE M. AMDAHL

Dr. Amdahl designed his first computer, the Wisconsin Integrally Synchronized Computer (WISC), after becoming frustrated with the use of calculators as a graduate student in physics at the Univ. of Wisconsin. He joined IBM in 1952, where he was the chief designer of the 704, initial planner for the 709 and 7030 (STRETCH), and manager of architecture for the 360.

He left IBM twice, the first time in 1956 to join Ramo-Wooldridge for a short time and then move to Aeronutronics, the second time in 1970 with the closing of the IBM Advanced Computing Systems Laboratory, of which he was director, as mentioned in this article.

Now he is chairman of Amdahl Corp., the company he founded after last leaving IBM, and principal designer of the Amdahl V series. Among other honors, he holds the W. Wallace McDowell Award from the IEEE Computer Society for his contributions to technical design and computer architecture, and DPMA's Computer Sciences Man of the Year Award, both of which he received in 1976.